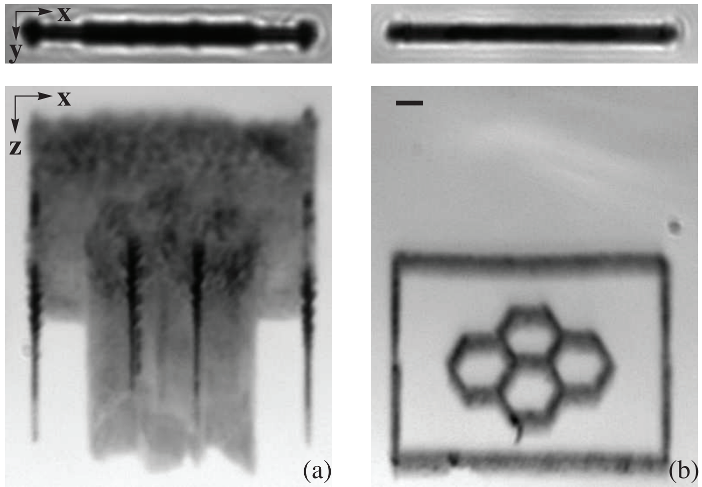

Fig. 5. Top (*xy*) and side (*xz*) view of graphitic structure fabricated in diamond. The midpoint of the structure is at a depth of 80 μm. (a) without aberration correction (b) employing the dual adaptive optics system. The laser beam was incident along the *z* direction. The scale bar represents 5 μm.

5. Conclusion

Compact graphitic structures have been fabricated deep in the bulk of diamond using a femtosecond laser and a dual adaptive optics setup, consisting of a SLM and DM, to correct for depth dependent aberration. Adaptive aberration compensation was shown to be crucial for maintaining controlled fabrication, allowing micron-scale structures to be fabricated down to depths greater than 200 μm. We have shown that adjustment of the writing beam power was not sufficient to generate features that were confined along the optic axis. This was due to the axial extension of the focal spot when aberrated by the refractive index mismatch present at the surface of the diamond substrate. Sharing the load of the aberration between the two adaptive elements led to increased fabrication efficiency compared to using the SLM alone.

The combination of femtosecond laser fabrication with high NA focussing and adaptive optics provides the capability to generate three-dimensional micron-scale structures deep within diamond. Subsequent reactive ion etching of the graphite, as has been demonstrated, for example, in combination with FIB machining [4], leads to the possibility of creation of complex high index contrast devices. These would have many applications in different areas of photonics. These dual adaptive methods also hold great potential benefit for optical microscopy, such as, for example, the observation of color centers in diamond [22].

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